THE USE OF GLOBAL POSITIONING AND GEOGRAPHIC INFORMATION SYSTEMS IN SOFT-SHELL CLAM SURVEYS

Donald J. Card
Maine Department of Marine Resources

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INTRODUCTION

History

In the early 1980s, the Maine Department of Marine Resources (DMR) was conducting a Marine Resources Inventory Project. The Inventory Project, funded by the Maine Department of Environmental Protection (DEP) and the Maine State Planning Office, was initiated in response to the threat of marine oil spills. Its primary focus was to identify, survey, catalogue and map marine resources at risk to oil spills for mitigation and damage assessment purposes. At this time the State of Maine was looking into the adoption of a Geographic Information System. Because resource mapping was one of the major tasks of the Inventory Project, the principal investigator was asked to participate in a series of meetings, workshops and conferences on Geographic Information Systems (GIS).

The value of GIS was not lost on the Administration at the time and eventually the state adopted what has become a comprehensive and robust program under the Office of GIS. Unfortunately, development of the technology and infrastructure was too long in coming for the DMR Resource Inventory Project, which was abandoned in the mid 1980s.

The development of the satellite based Global Positioning System (GPS) and its subsequent refinement during the late 1990s vastly improved the versatility of GIS by providing real time, precise location data from the field. Data logging GPS receivers soon became a major contributor to the data collection process.

In mid 2000, the DMR Watershed Division obtained a Trimble GeoExplorer 3 data logging GPS unit with Pathfinder Office GIS software. A Watershed staff member had also been the principal investigator with the Resource Inventory Project and saw the acquisition of the GPS unit and GIS software as the opportunity to develop a valuable tool for the division.

GPS-GIS Project

The Watershed Division is responsible for municipal shellfish program oversight. One aspect of the Watershed Division's mission in which the GPS-GIS combination could prove useful is clam surveys. Clam surveys are conducted to ascertain the status of soft-shell clam populations in managed areas. The systematic random surveys consist of sampling two square feet plots dug at designated intervals (usually 50', 100' or 200') along parallel transects spaced at the same interval throughout the clam producing area. The clams at each plot are counted, measured and recorded. The field data is then analyzed, using formulae developed from length/volume studies, to produce clam densities, standing crop and size distribution. This information is used in management decisions such as license allocations and conservation closures.

The goal of this project was to examine the feasibility of using GPS and GIS to enhance the clam survey process. In order to accomplish the objective it was necessary to establish the necessary procedures for their use and to develop appropriate products in addition to those currently provided. This report documents those efforts. Please note, however, that it was beyond the scope of this report to describe GPS and GIS and it is assumed that the reader has some basic knowledge of them.

OVERVIEW

Hardware

The GPS unit used in this project was the Trimble GeoExplorer3®. The GeoExplorer is a "data logging" unit that is capable of data input and storage. When in the field, spatial data (location and elevation) and time are obtained from the constellation of GPS satellites and stored in the unit. Other data can be inputted by keyboard if the unit is programmed to accept it. Once field operations are completed, the data can be downloaded to a computer for processing. The computer used in the project was an IBM ThinkPad®.

Software

The companion software for the GeoExplorer is Pathfinder Office® (2.51). The software has both GPS and GIS functionality. Prior to fieldwork, the software is used to create, and upload to the GPS unit, a data dictionary that is a set of attributes in the form of scroll down lists. In the field the data dictionary is used to input data (select a menu item or enter a number for each attribute) at each location (feature). Back in the office the software is used to download and process the data from the GPS unit. The software is also used to manage and display the data.

GPS Setup

In order to utilize GPS-GIS for clam management surveys, a data dictionary had to be created using Pathfinder. There are 24 datum recorded at each survey plot (feature). Date, time and location are automatically recorded; the remainder must be entered. The entered data include a plot number, plot size, plot interval, the presence or absence of clam spat and the number of clams in size increments of 0.5 cm (1-10 cm). Once the data dictionary was created and uploaded to the GPS unit, fieldwork could begin. Table 1 is a schematic of a 'Clam Survey Data Dictionary'.

Field Work

Data collection in the field for clam management surveys is an ongoing operation while the survey is being conducted. Each survey plot is a distinct location and data needs to be logged at each. The operation begins with activating the GPS unit and in a few minutes it will initialize (acquire enough satellite transmissions to calculate a position). At each sampling plot the location-recording feature is activated, the input data is logged and then the location-recording feature is inactivated to complete data storage. This is repeated for each sampling plot. Each plot is recorded as a designated feature with its specific attributes. Fieldwork is complete once the last plot is recorded and the GPS unit shut down.

Office Work

Back in the office, data can be downloaded from the GPS unit into the computer with the GIS software. The software is then used to perform a number of functions including data processing, management, display as well as export to other GIS programs.

Using the software, the location information can be made more accurate through differential correction. Differential correction is a process that uses GPS signals received by a local fixed based station at the time of data collection to correct for aberrations to the signal due

to atmospheric conditions and other forms of interference. The corrections are obtained from the base station through the Internet.

The software will display the corrected location data as a point or points on a background map (topographic map previously downloaded from the Internet). This map can be printed with formatted information such as title, lat/long, scale bars and etc. In addition, an information box can be opened which shows all of the attribute data for each point.

The data can be exported to a spreadsheet for further processing. The data can also be exported as files suitable for other GIS programs such as ArcView®.

PROCEDURES

This section describes the specific operational procedures developed for use with the GeoExplorer3® and the Pathfinder Office® and Microsoft Excel® programs.

Creating Projects

When PathFinder opens, a Select Project dialogue box opens with a Default Project Name. Select New, which opens a Project Folders dialogue box. Entering a separate project name for different projects keeps things organized. Enter a project name (e.g., Management) in the Project Name: space. Choose a directory such as *MyDocs/ Management* for the Project Folder: space and select OK. Whenever opening PathFinder, select the appropriate project.

Creating a Data Dictionary

A data dictionary created in PathFinder and transferred to the DataLogger prior to fieldwork determines the data recorded by the DataLogger. The DataLogger will collect data (aka: attributes) for each point (aka: feature) selected. An outline of the data required for each point prepared before creating the data dictionary expedites the process.

Open PathFinder and select the Project from the Select Project dialogue dropdown list. Select Utilities from the toolbar and Data Dictionary Editor from the dropdown list. The Data Dictionary Editor dialogue box will open. Enter a Name such as *Clam Survey* and a Comment if wanted. Select New Feature and when the dialogue box opens enter a Feature Name such as *Plot* and select Point as the Feature Classification and then OK. The Data Dictionary Editor will open with *Plot* listed under Features.

The data to be gathered for each point is now entered as attributes, select New Attribute and the type when the New Attribute Type dialogue box opens. When you chose Menu, you need to enter an Attribute Name and then select New and then an Attribute Value name when the New Attribute Value – Menu Item dialogue box opens followed by selecting Add, repeat for each Attribute Value. For example, the Attribute may be *Spat* and the Attribute Values may be *Yes* or *no*. The addition of other types of Attributes such as Numeric, Date and Time are self-explanatory.

Data dictionary outlines prepared for clam surveys are contained in the appendix.

Creating Waypoints

Waypoints are position only data points that can be created in PathFinder and transferred to the DataLogger or created in the field with the DataLogger. Waypoints can be used to locate positions in the field or mark a location for navigation purposes.

To create a waypoint, open PathFinder and select File from the toolbar and Background from the dropdown list. Follow the procedure in the section Adding a Background Map to display a map of a subject area. Use the Zoom tool (magnifying glass icon) to obtain the proper scale. Select File from the toolbar, Waypoints from the first dropdown list and New from the second. The New Waypoint File dialogue box will open. Choose a location for the waypoint file such as *MyDocs/Management/PFData/Waypoints* (you will have to create this file the first time) in the Save in dropdown list. Use the default file name or a more descriptive one in the File name: block. Select OK. The Waypoint Properties dialogue box will open; select Create. The default name or another can be used in the Name box and North and East coordinates entered to create the waypoint. If the Pick From Map box is checked, the cursor can be used to pick off the waypoint from the map, selecting Save completes the operation and another Create Waypoint dialogue box will open. Select Close when done.

If a series of waypoints is needed, such as sampling locations, these can be picked off the map. The location of the cursor is shown in the bottom left hand corner of the program window and can be used to determine distances between the sampling locations (e.g., for a 30m N-S/E-W grid). For a large number of locations, it would be better to follow the following procedure. Using the cursor, determine the N-S and E-W boundaries of the subject area. Use Notepad to create a text file of waypoint coordinates. Begin with the first waypoint by typing the East coordinate then the North coordinate making sure there is a space between the two numbers. On a new line, type the coordinates of the second waypoint in the same way. Repeat with each waypoint pair of coordinates. This will result in two columns of numbers separated by a space. Name and save the file in the *Waypoint* folder. Select File from the toolbar then Waypoint from the first dropdown list and Import ASCII File from the second; this will open the Import ASCII Waypoint File dialogue box. Select All Files from the File Type dropdown list. Locate the text file and select it. The Coordinate System dialogue box will open; select OK. The text file will be converted to a waypoint (*.wpt) file and the waypoints will appear on the map. Delete any waypoint that is not needed, additional waypoints can be added with the cursor as detailed above.

Transferring Files: PathFinder to DataLogger

Data Dictionary or Waypoint files will have to be transferred from the PathFinder program to the DataLogger prior to fieldwork. With the DataLogger in the cradle, open PathFinder and select Wetlands from the Select Project dialogue box dropdown list and OK. Select Utilities from the toolbar and Data Transfer from the dropdown list. The Data Transfer box will open listing Available Files on the DataLogger. Select the file to transfer and Add. The file will appear in the Selected Files list. Select Transfer and the files will be sent to a default directory or one of your choosing.

Collecting Data for One Feature

Upon arriving at the site of the fieldwork, power up the DataLogger, a satellite acquisition screen will appear. The DataLogger will take a minute or so to acquire available satellites. A minimum of three satellites is needed to log position data. When ready, press the

Data button and a Collect New Data screen will appear. Check the Dictionary display to ensure it coincides with the particular project. It can be changed by using the arrow keys to highlight it then hit the Enter key; then again using the arrow keys and Enter key to select the correct dictionary from the Dictionary scroll down list. Highlight Create New File and select it with the Enter key. This will bring up the New Feature screen. You will be asked if GPS positions are to be logged now or later, use the arrow keys and Enter key to choose. If you are at a position that you want to log position data, select Now; a beeping icon in the lower right corner will indicate the number position data points being logged. If you are not in a position to log position data, select Later; a blinking pause icon will appear in the lower right corner of the screen, press the Log key to begin position logging when ready. Use the arrow keys and Enter key to scroll through attribute list and enter the appropriate data. When completed, hit the Log key to pause the position-logging feature. Power down to complete the operation.

Collecting Data for Multiple Features

When multiple features need to be recorded at a site, follow the procedures just described with the following exception. When position logging and data input are completed for the first feature, press the Log key to pause position logging. Proceed to the next feature site. Press the Close key to save the data from the last feature; this will also open the New Feature screen. Continue this procedure for each feature. Press the Close key and power down to complete the operation.

Transferring Data: DataLogger to PathFinder

With the DataLogger in the cradle, open PathFinder and select Management from the Select Project dialogue box dropdown list and OK. Select Utilities from the toolbar and Data Transfer from the dropdown list. The Data Transfer box will open listing Available Files on the DataLogger. Select the file to transfer and Add. The file will appear in the Selected Files list. Select Transfer and the files will be sent to a default directory or one of your choosing.

Differential Correction of Data

Select Utilities from the toolbar and Differential Correction from the dropdown list. The Differential Correction dialogue box will open with the transferred file listed under Rover Files: Selected Files. Select the file and Internet Search. The Internet Search dialogue box will open and show the current Base Data Provider, select OK. Select Yes on the Confirm Internet Setup dialogue box. A Confirm Selected Base Files dialogue box will open, select OK. A Reference Position dialogue box will open; select OK. The Differential Correction dialogue box will open with an entry under Base Files: Selected Files; select OK. A number of dialogue boxes will confirm correction.

View Data

Select File from the toolbar and Open from the dropdown list. The Open dialogue box will open with the *PFData* file in the dropdown list window. Select the file to view and Open. Select View from the toolbar and Map from the dropdown list. A project symbol will appear in the center of the map. Select Data for the toolbar and Feature Properties from the dropdown list, a Feature Properties dialogue box will open listing the attributes data collected in the field.

Adding a Background Map

To acquire a topo map, open the browser and go to the Maine GIS website. Select the 24 Tile tab and then the drgclip link. Select the Next tab, which will bring up the list of 7.5" series topographic maps for Maine. Select the appropriate map and then Show Data; the map will be shown as a ZIP file, select Download. A File Download dialogue box will appear, select Open. The file will download to a temporary file and the WinZip program will open. Follow the instructions to unzip the file. Rename the two unzipped files with the map name but leave the extensions the same and move the files to the directory: *MyDocs/Management/PFData/Maps*.

To add the topo map as background, select File from the toolbar and Background from the dropdown list. The Load Background Files dialogue box will open. Select Add and the Add Background Files dialogue box will open with a list of background files in the *Maps* directory. Select the right file and Open; the file will then be listed in the Load Background Files dialogue box. Note: the GIS files are UTM coordinated, be sure the coordinate system listed in this dialogue box are Universal Transverse Mercator 19 North NAD 1983 HPGN (Maine), also select Options from the toolbar and Coordinate System from the dropdown list; the system, zone and datum should be the same, if not, change it. Close the dialogue box. If the background map does not show, select View from the toolbar and Zoom then Extents from the dropdown lists. Use View: Zoom: In/Out to view the map at different scales.

Plotting a Project Map

In map view with the background loaded and set to the desired scale, select File from the toolbar and Plot Map from the dropdown list. The Plot Map dialogue box will open; enter a Plot Title. Check the scale and select Grid type from the list. Select Preview to see how the map will appear, then Print. To change page orientation, select Close then Setup then Portrait or Landscape and OK.

Exporting to and Creating a Spreadsheet

The data from each DataLogger file (feature attributes) can be exported into a spreadsheet such as Excel. Select Utilities from the toolbar and Export from the dropdown list, this will open the Export dialogue box. The current open file should be listed in the Input Files list and the Output Folder should show the following directory: *MyDocs/Management/PFData/export.* From the Choose on Export Setup dropdown list, select Sample Configurable ASCII Setup then OK.

To set up an Excel spreadsheet, open a blank Excel Workbook. Select Data from the toolbar and Get External Data from the first dropdown list and Import Text File from the second. The Import Text File will open, select All Files from the Files of Type dropdown list and brows for *MyDocs/Management/PFData/export.* Select the subject file (it has an ATT extension). The Text Import Wizard will open. Select the Delimited radio button and Next. Select the Comma Delimiters box and Next. Select the General radio button and Finish. The Import Data dialogue box will open. You can choose where the data will be placed on the spreadsheet by clicking on any cell then selecting OK. Titles, headings and other spreadsheet items can then be added and the Workbook can be saved.

To add data to the saved Workbook follow the directions in paragraph one. Instead of opening a blank Workbook as directed in paragraph two, open the saved Workbook and continue.

PRODUCTS

Clam surveys begin with the first plot placed randomly within a few feet of the flat access point. The 1' x 2' plot is dug to a depth of a foot and all clams are countered, measured to the closest half centimeter and recorded on a data sheet. At that point, a decision is made as to the best direction to go to establish another plot, the two plots describing a line that will be the bases of a main transect upon which all of the other transects and plot locations will depend. In a large flat, parallel and perpendicular transects spaced 100' apart will describe a grid with plots at the intersection of perpendicular transects. This provides for systematic spacing and allows for accurate area determination and the basis for mapping. Once the entire clam producing area is surveyed and the data recorded, the fieldwork is concluded.

In the office, the data is compiled and entered into an Excel spreadsheet, which calculates size distribution, average clam density and estimated standing crop. Figure 1 is a sample spreadsheet summary page for one surveyed flat.

The use of GPS and GIS add a couple of additional products to the standard spreadsheet: a precise map of the flat showing plot locations and a spreadsheet file of data suitable for import into the standard analysis spreadsheet eliminating the need of compiling and entering data by hand. Figure 2 is a sample map of a surveyed flat. The map is produced with the Pathfinder Office software utilizing data obtained by the GeoExplorer3 during the survey. The plot locations are shown as red dots on a 3.5-minute topographic map of the area at a scale of 1:10,000. Figure 3 is a sample spreadsheet data page created by importing spreadsheet files from Pathfinder Office containing the data obtained by the. GeoExplore3.

One of the nicer features in using GPS and GIS is the ability to establish plot locations in the office with Pathfinder as waypoints that can be downloaded to the GeoExplorer. The GeoExplorer can then be used in the field to locate each plot thus eliminating a lot of guesswork in the field.

In addition to these products and capabilities, Pathfinder database files can be exported as ARC/INFO or ArcView files for integration into the state GIS system.

CONCLUSION

With a history that goes back to the early 1980s, the State of Maine has been heavily invested in GIS for its data management needs. Many state agencies have taken advantage of the capability of GIS and the services of the Office of GIS. It is presumed, however, that there are many agency programs that could utilize and benefit from GIS but the lack of knowledge, vision or funding have stalled its adoption to a greater extent. Fortunately, these three elements came together at the DMR Watershed Bureau and this study was undertaken.

Once the appropriate hardware and software were obtained, it was necessary to integrate utilization of GPS and GIS into the existing clam survey procedures. This required the development of specific processes within the hardware and software. This was accomplished behind the desk and in the field over a couple of years and is documented in this report.

The work has resulted in an enhanced survey procedure. The ability to pre-select sampling plots not only streamlines the survey process but also allows for alternate sampling schemes such as stratified random sampling. The use of a data logging GPS supplants the clipboard, pencil and data sheets and with the GIS software eliminates hand data compilation prior to analysis. The addition of accurate survey maps to the survey products and the ability to integrate the clam survey data into the state GIS makes a GPS-GIS combination a great addition to the survey toolbox.

Figure 1

Soft-shell Clam Survey Results

Flat: Small Cove
Town: Myaville
Date: 01/01/04

Interval: 100
Plots: 5
Area (ac): 1.1

Measure	Length (mm)	Number	Percent (n)	Density (bu/ac)	Crop (bu)	Percent (c)
10	6-10	0	0.00%	0.00	0	0.00%
15	11-15	0	0.00%	0.00	0	0.00%
20	16-20	2	1.79%	0.22	0	0.09%
25	21-25	4	3.57%	0.96	1	0.39%
30	26-30	4	3.57%	1.77	2	0.72%
35	31-35	7	6.25%	5.15	6	2.11%
40	36-40	18	16.07%	20.05	23	8.21%
45	41-45	26	23.21%	43.32	50	17.73%
50	46-50	23	20.54%	53.68	62	21.97%
55	51-55	12	10.71%	37.92	44	15.52%
60	56-60	10	8.93%	41.64	48	17.04%
65	61-65	3	2.68%	16.08	18	6.58%
70	66-70	1	0.89%	6.76	8	2.77%
75	71-75	2	1.79%	16.79	19	6.87%
80	76-80	0	0.00%	0.00	0	0.00%
85	81-85	0	0.00%	0.00	0	0.00%
90	86-90	0	0.00%	0.00	0	0.00%
95	91-95	0	0.00%	0.00	0	0.00%
100	96-100	0	0.00%	0.00	0	0.00%
	Totals:	112	100.00%	244.33	281	100.00%
	Legal:	28	25.00%	119.19	137	48.78%

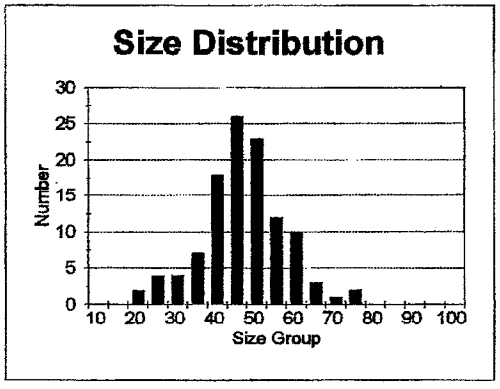
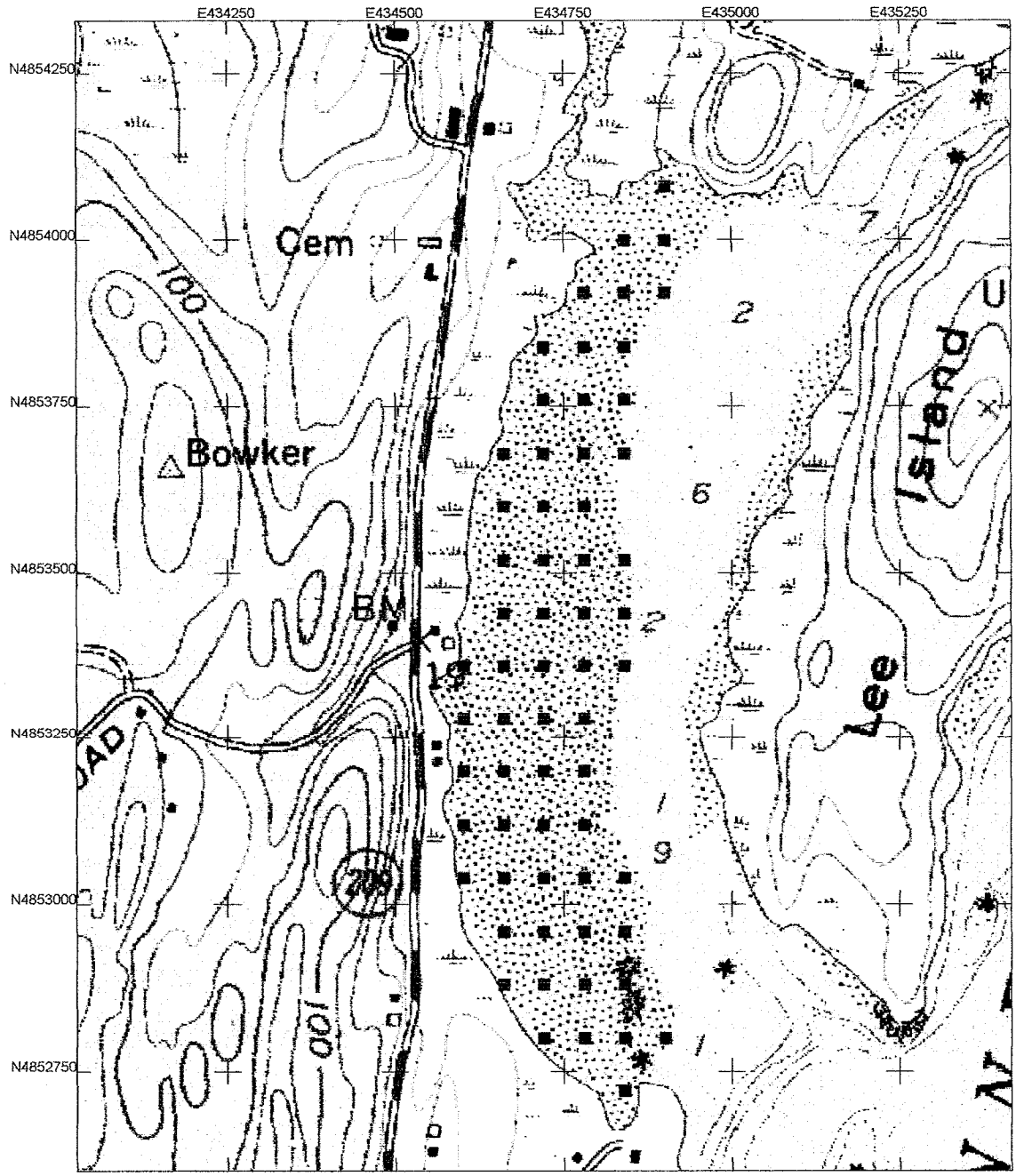


Figure 2

GPS Import Data

Item	Name	Number	Interval	Area	Clams	Spat	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
1	Plot	1	100	2	yes	0	0	0	0	0	1	1	2	5	4	2	1	0	0	0	0	0	0	0	0
2	Plot	2	100	2	yes	0	0	0	0	0	0	1	5	2	5	5	1	0	0	2	0	0	0	0	0
3	Plot	3	100	2	yes	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
4	Plot	4	100	2	yes	0	0	0	0	2	1	0	0	5	3	2	8	3	1	0	0	0	0	0	0
5	Plot	5	100	2	yes	0	0	0	2	2	2	5	11	13	10	2	0	0	0	0	0	0	0	0	0
					Total	0	0	0	2	4	4	7	18	26	23	12	10	3	1	2	0	0	0	0	0

Figure 3



Clam Survey Plots

Universal Transverse Mercator
19 North
NAD 1983 HPGN (Maine)

N

Scale 1:10000

0 0.300

Kilometers

6/28/2002

Pathfinder Office

Trimble

Table 1

Clam Survey Data Dictionary

Point Feature: Plot

Attribute	*Numeric/Menu*
Plot Number	[##]
Interval	[50|100|200]
Plot Size	[2|1|.5|.25]
Clams	[yes|no]
Spat	[##]
1	[##]
1.5	[##]
2	[##]
2.5	[##]
3	[##]
3.5	[##]
4	[##]
4.5	[##]
5	[##]
5.5	[##]
6	[##]
6.5	[##]
7	[##]
7.5	[##]
8	[##]
8.5	[##]
9	[##]
9.5	[##]
10	[##]